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Identifying Aboveground Wood Fiber Potentials in New York State

Eric H. Wharton

Abstract

New York forests are made up of more than just the growing stock that is measured during conventional forest inventories. A biomass inventory, completed in 1980, showed that New York commercial forest lands contain nearly 1,164.4 million green tons of aboveground tree biomass, or an average of 75.6 green tons per acre. Conventional growing stock accounted for 57 percent of the total wood fiber supply. The rest was nongrowing stock that includes cull trees, previously noncommercial tree species, small trees, and tree tops. Utilization studies conducted in New York showed that 1.7 million green tons of wood residues generated by harvesting and processing industrial wood products are not being used, but that such residues could be recovered for certain forest products. Standing aboveground tree biomass may be more expensive to recover than residues because of such physical and socioeconomic constraints as tract size, terrain condition, and the attitude of forest-land owners toward harvesting.

The Author

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Identifying Aboveground Wood Fiber Potentials In New York State

Eric H. Wharton

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Highlights

- Almost 1,164.4 million green tons of aboveground tree biomass were estimated to be on New York's commercial forest lands (public and private lands excluding forest preserves) in 1980.
- Softwoods account for more than 268.6 million green tons of aboveground tree biomass (23 percent) and hardwoods account for almost 895.8 million green tons (77 percent).
- Concentrations of aboveground tree biomass average 75.6 green tons per acre of commercial forest land.
- Conventional growing stock accounts for 57 percent of the aboveground tree biomass statewide. The tops of growing-stock trees account for 18 percent, cull trees for 9 percent, and other sources for 16 percent.
- Four percent of the aboveground tree biomass harvested for sawlogs and veneer logs, 20 percent of the biomass harvested for pulpwood, and 87 percent of the biomass harvested for fuelwood came from nongrowing stock.
- Logging and processing industrial wood products generated 1.7 million green tons of unused wood residues.
- Fifty percent of the aboveground tree biomass is in stands of less than 50 acres and therefore may be unavailable for mechanized harvesting like whole-tree chipping.
- Sixty-nine percent (9.9 million acres) of the commercial forest land in New York belongs to private forest-land owners who are willing to have timber harvested from their land.

Background

The U. S. Forest Service periodically inventories every state in the nation, assessing each state's timber resources and how they are being used. The Forest Inventory and Analysis unit of the Northeastern Forest Experiment Station has inventoried New York's timber resources on three occasions, first in 1953, and for the second time in 1968. After the third and latest inventory was completed in 1980, Considine and Frieswyk (1982) and Considine (1983) reported on a new portion of the resource; biomass estimates were included which can be used to identify additional sources of wood fiber.

Most of the interest in estimating biomass has originated only within the last decade, although the techniques are not new. Young pioneered much of the biomass research (Young 1979), but such research was not given much attention in the United States until the 1970's.

The energy crisis that was first felt in 1973 and the growing acceptance of whole-tree chipping are two important reasons why interest in estimating biomass has increased. This author and others have discussed these reasons in the literature. Now we must satisfy the increasing demand for information about the wood fiber supply.

Much of the data that is collected during conventional forest inventories can be used to estimate biomass. Biomass data can be generated by applying average weights per tree to stand table data (numbers of trees by diameter class from previous inventories). This technique was used in a previous study to supply biomass statistics for each state in the Northeast when national biomass tables were being compiled for the first time (U.S. Department of Agriculture 1981).

New York was included in this early attempt to assess biomass, but the statistics did not provide the detail necessary to analyze the wood fiber supply adequately. Softwoods and hardwoods at the state level were the finest breakdowns that could be provided.

The third inventory of New York has provided an opportunity to more closely examine the biomass resource, although other biomass estimates have been made. The New York State Energy Research and Development Authority has funded one such study (Research Foundation of State University of New York 1980) and Monteith (1981) has published a comprehensive report on the availability of New York biomass.

This publication is a recent attempt to quantify the wood fiber resource in New York. To estimate this resource, biomass equations were applied to tree data that was collected during 1978-79. I will report on the aboveground tree biomass resource on commercial forest land in New York, how the state's timber industry is using the resource, and what may be available for future use from residues and standing timber.

The biomass statistics are summarized by county, geographic unit, principal region, and state. County-level statistics are less reliable than unit-, region-, or state-level statistics because the sample sizes of the estimates are smaller. If this fact is recognized, the report should be a valuable asset to resource planners, timber harvesters, wood processors, and forest-land managers.

Definitions

It is usually unnecessary to publish an account of U.S. Forest Service definitions in our resource reports, except as an appendix. Most of the standards are well known, but the use of the term biomass[1] has raised many questions about just how much of the total wood resource we are really measuring. For this reason, a section of definitions seems appropriate, beginning with our previous inventory standards.

I do not mean previous in the sense that the standards will become outdated. Board foot is an accepted measure of sawtimber volume, and cubic foot is an accepted measure of growing-stock volume. It is also important to measure the forest in terms of weight because whole-tree chipping and weight scaling are becoming more common. Biomass is a simpler method of measuring the amounts of certain portions of the forest resource.

[1]This term and others are defined in the glossary.

The amount of woody material in sawtimber can be quantified by using the board foot measure. Sawtimber is the portion of the main stem between a 1-foot stump height and a 9-inch top diameter outside the bark (7-inch top for softwoods), or to the point where the main stem breaks up if that is before it reaches this minimum diameter (Fig. 1). Trees must be at least 11.0 inches dbh (diameter at breast height) for hardwoods and 9.0 inches dbh for softwoods.

Growing stock includes more of the tree stem, and is measured in cubic feet. It is the portion of the tree stem between a 1-foot stump height and a 4-inch top diameter outside the bark, or again to the point where the main stem breaks up if that is before it reaches this minimum diameter (Fig. 1). Trees must be at least 5.0 inches dbh.

Trees smaller than 5.0 inches dbh, cull trees, noncommercial tree species, and dead trees are excluded from both sawtimber and growing stock. Although the net cubic foot content of cull trees to a 4-inch top is estimated, it is not included in the total growing-stock volume estimates.

The biomass estimates presented here are the green weight of wood and bark in merchantable stems, tree tops, stumps above the ground, trees between 1.0 and 5.0 inches dbh, cull trees, and noncommercial tree species. These weight estimates are for the live, aboveground tree biomass component of the total forest resource (Fig. 1). Some portions of the resource are excluded, such as foliage, rotten wood, dead trees, shrubs and undergrowth, and the stump-root system below the ground.

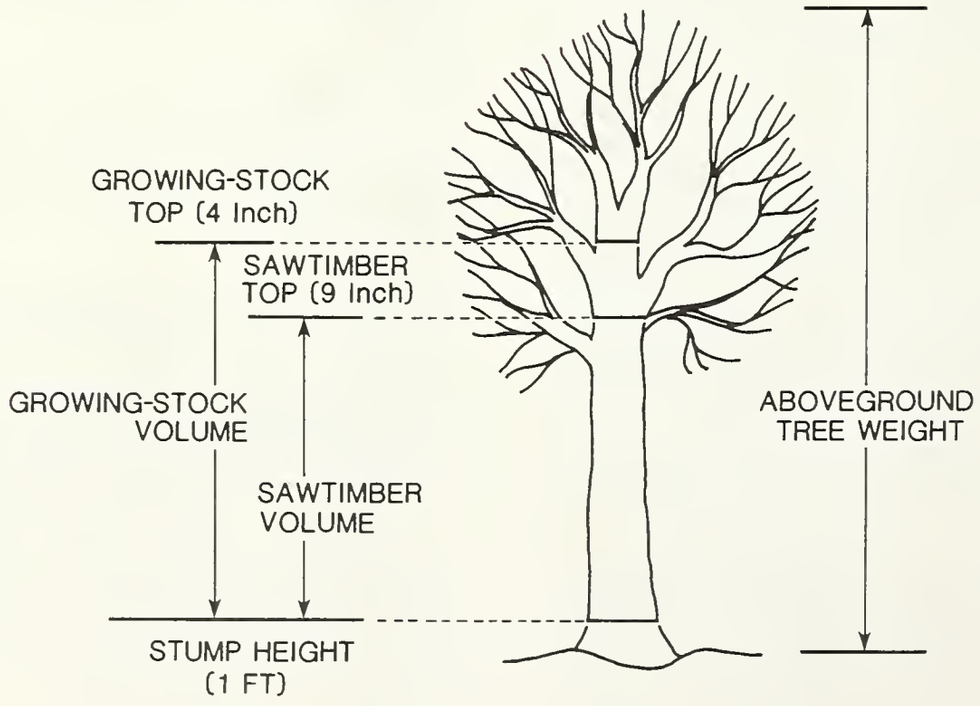

Figure 1.-- Volume and weight relationships of hardwood aboveground tree biomass components.

The Standing Wood Fiber Supply

New York commercial forest lands contain almost 1,164.4 million green tons of aboveground tree biomass (Table 1). New York is not one of the most heavily forested states in the Northeast, but because of its large commercial forest land area it has one of the largest total amounts of aboveground tree biomass. In the Northeast, only Maine and Pennsylvania have significantly greater amounts of aboveground tree biomass (U.S. Department of Agriculture 1981).

New York is in the middle of the northern hardwood forest. There are more than 268.6 million green tons of softwood, but nearly 895.8 million green tons of hardwood aboveground tree biomass (Tables 2 and 3). The proportions of individual species in this predominantly hardwood forest will differ depending on the region of the state.

Species Composition

The Northern and Southeastern regions both contain higher proportions of softwoods than the Southwestern region (Fig. 2), but for different reasons. Although primarily hardwoods, spruce and fir make up a significant proportion of the tree cover in the Northern region. This region is on the edge of the northern coniferous forest that extends through Maine. Here, 30 percent of the aboveground tree biomass is in softwood species. The forests in the Southeastern region are 25 percent softwood, but contain more white and red pine than the Northern region. The Southeastern region is part of the southern hardwood forest that extends up through eastern Pennsylvania and along the eastern side of the Hudson River Valley. Pines, hemlocks, and oaks predominate here. In fact, the greatest proportion of oak aboveground tree biomass -- 23 percent -- occurs in this region.

The Southwestern region is typical of the northern hardwood forest. Maples predominate, with hemlock the only important softwood species. Here also is a large amount of an underutilized species: red maple. This species has increased more in volume than any other species. Red maple has become a significant component of the oak-hickory and northern hardwood timber stands already established throughout the state. Although red maple accounts for 20 percent of the growing-stock volume found on commercial forest land (Considine and Frieswyk 1982), only 7 percent is harvested for industrial wood products (Nevel and others 1982).

Red maple is only one example of how the resource responds to timber harvesting practices. Frequently, wood is processed by trying to fit the resource to a single product, rather than fully utilizing the resource for whatever products it may yield. As a result, certain species are underutilized and become major components of some timber stands.

Such underutilized species may not continue to predominate. Most stands of timber will revert to the climax types, except where these climax types like oak are held in check by insect, disease, and animal damage. In the meantime, the resource could be used more fully by harvesting previously undesirable[2] tree species along with tree tops and cull trees for pulp, reconstituted board products, and energy.

Concentrations

Knowing biomass by species is important, but management decisions are also based on concentrations of biomass. New York timberlands average an estimated 75.6 green tons of aboveground tree biomass per acre of commercial forest land (Table 4). Higher concentrations of aboveground tree biomass are found in the eastern geographic units, while lower concentrations are found in the western units; the lowest concentrations are found in the Lake Plain unit. In this unit, the best sites have been converted to agriculture or have been urbanized, and the remaining sites contain smaller concentrations of biomass than other parts of the state.

Certain areas may have heavy concentrations of biomass, but low proportions of commercial forest land (Fig. 3 and 4). This situation usually occurs in agricultural or urban-suburban areas in the state, but also occurs in heavily forested areas that have been free of large-scale agricultural and urban-suburban encroachments over the years.

Counties in the Eastern Adirondack unit are an example of areas with heavy concentrations of biomass and small proportions of commercial forest land. Biomass in these counties average 90.0 green tons per acre, but the proportion of commercial forest land here is only slightly higher than most counties in the Lake Plain unit. In the Eastern Adirondack unit, a high proportion of reserved forest land decreases the amount of forest land commercially available. A large quantity of biomass may seem available, when in fact the stands may be separated by areas reserved for recreational or other purposes.

A little less than half of the aboveground wood resource has largely been ignored by conventional inventories in the past. Most of the aboveground tree biomass in New York is in growing stock (Table 5). Nearly 657.0 million green tons -- 57 percent of the aboveground tree biomass -- are in merchantable stems. An additional 213.4 million green tons -- 18 percent of the aboveground tree biomass -- are in the tops of growing-stock trees. These tree tops, plus other sources of nongrowing stock account for nearly 507.4 million green tons, or 43 percent of the aboveground tree biomass.

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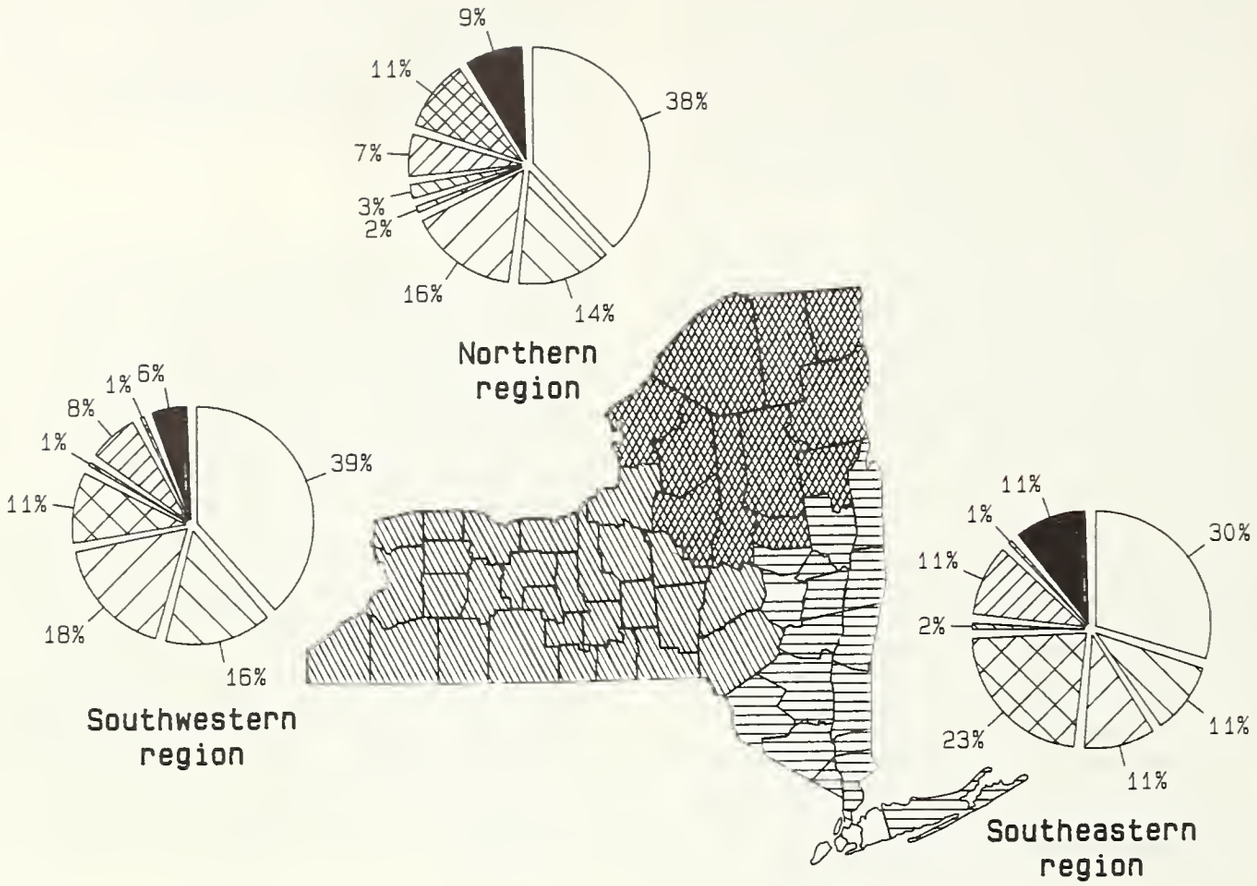
[2]Undesirable for conventional forest products. The forest products industry is changing and terms like merchantable, commercial, and undesirable no longer apply.



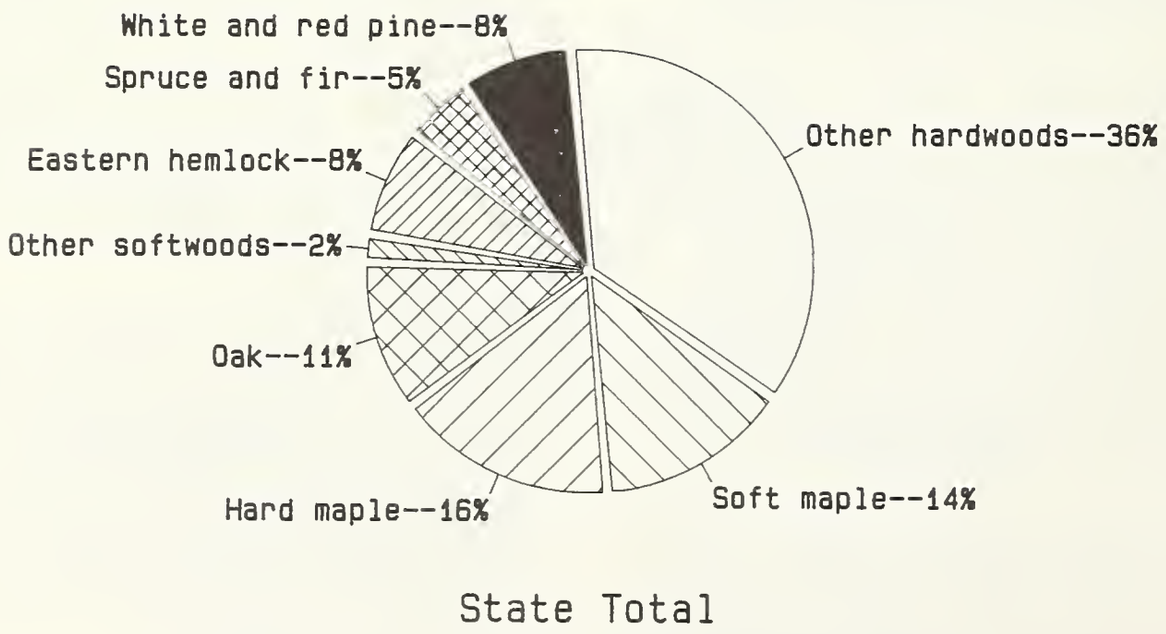


Figure 2.--Species distribution of aboveground tree biomass by geographic regions in New York, 1980.

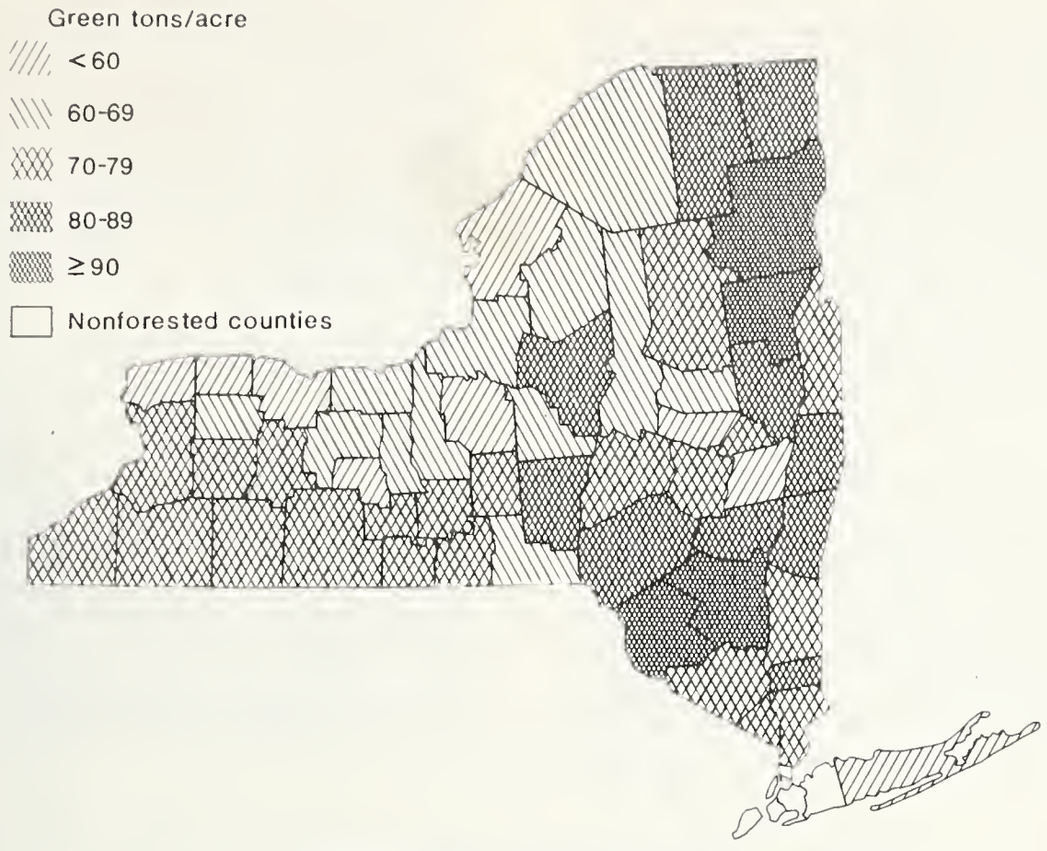


Figure 3.--Concentrations of aboveground tree biomass in New York, 1980.

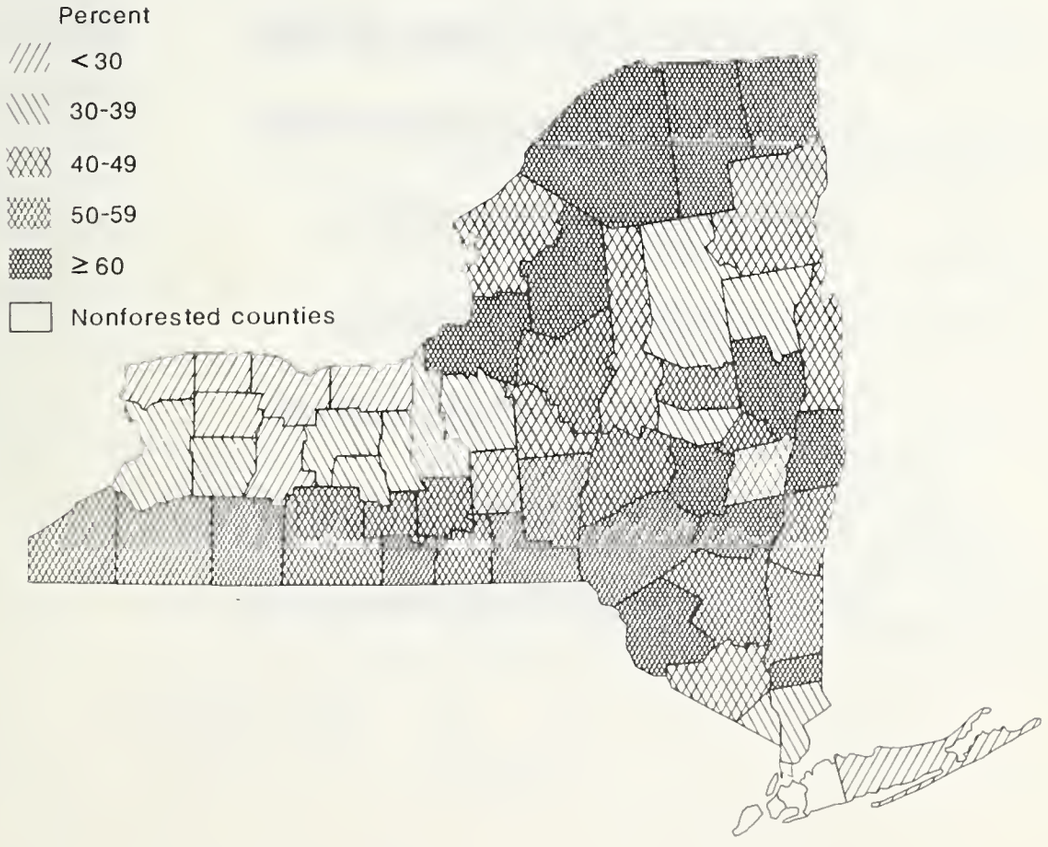


Figure 4.--Distribution of commercial forest land in New York, 1980.

The proportion of nongrowing stock indicates much about the characteristics of the resource in the different units, and what additional sources might be available to be recovered. Nongrowing stock accounts for nearly as much aboveground tree biomass as does growing stock in the St. Lawrence - Northern Adirondack and Western Adirondack units (Fig. 5). Timber stands here are not in prime condition; many of the trees may be of poor form, excessively branchy, or contain mostly rot. Improving recovery in the two units involves harvesting mostly small, poorly-formed, and rotten trees. Such a process is both time consuming and costly with current harvesting techniques.

In some units, like the Southwest Highlands unit, not much more than tree tops could be recovered after industrial wood products are removed because the proportion of cull trees and other sources of biomass like small trees is low compared to other units. Conversely, harvesting aboveground tree biomass is a good opportunity to clean up stands that are in poor condition in the St. Lawrence - Northern Adirondack and Western Adirondack units.

Current Wood Fiber Use

The Forest Inventory and Analysis Staff send out questionnaires to all wood manufacturers during the year when the inventory is conducted. For that year, we assess how much timber is being produced and consumed in the state. Our canvass of New York wood manufacturers shows that nearly 4.8 million green tons of wood fiber were removed for industrial forest products during 1979, and that the majority -- 77 percent -- was hardwood species (Table 6).

The proportion of hardwoods harvested is fairly constant throughout New York, but certain regions of the state show considerably less harvesting activity than others. Southeastern New York, for example, has 26 percent of the aboveground tree biomass, but only 19 percent of the total harvest occurs there. Northern New York, conversely, has 35 percent of the resource, but almost 48 percent of the harvesting in New York is done there. The characteristics that affect timber harvesting in the three regions have been discussed by Nevel and others (1982). A better indication of wood fiber use in New York is the source of wood used for various products, rather than just the proportion of biomass harvested.

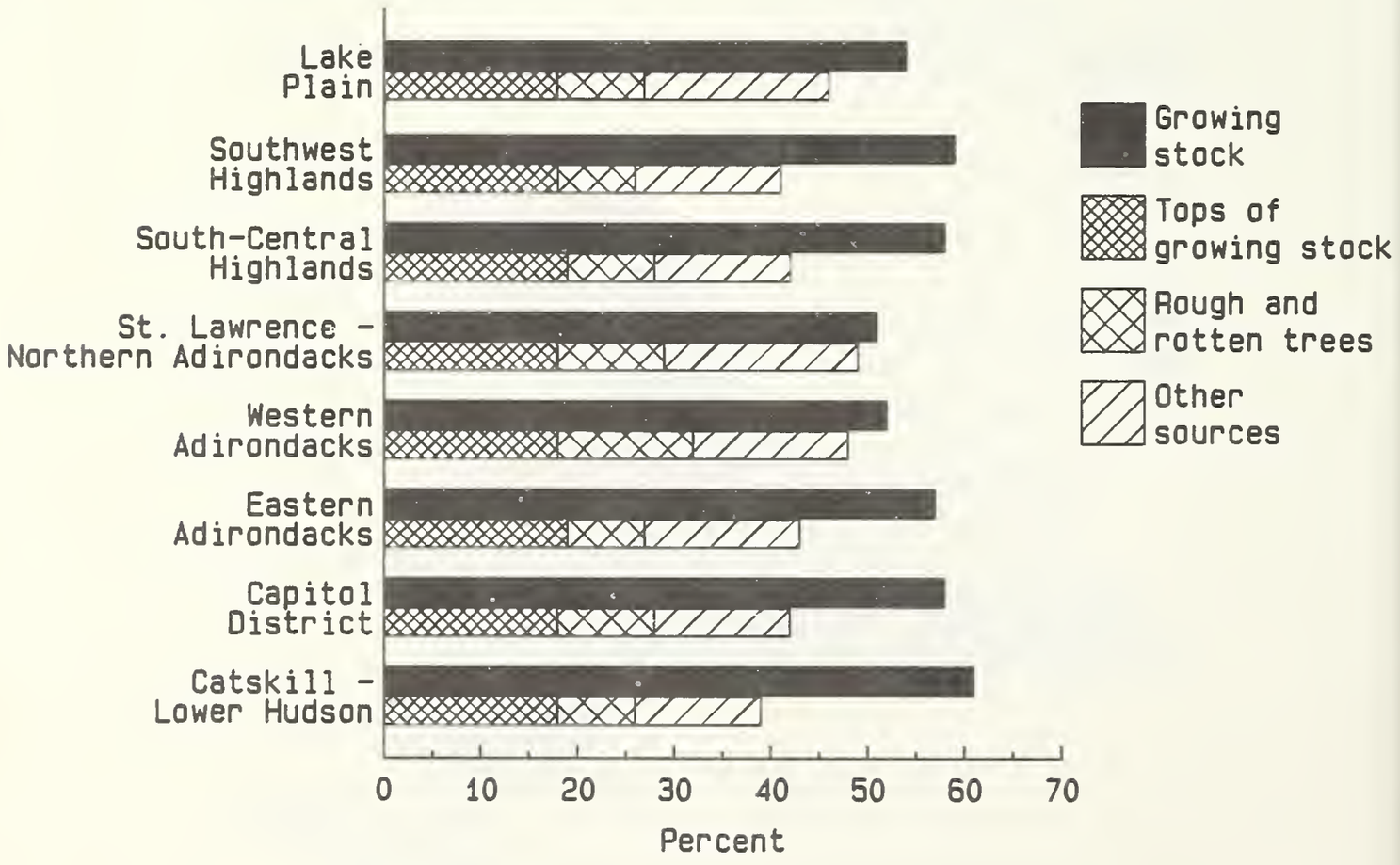


Figure 5.--Components of aboveground tree biomass by geographic units in New York, 1980.

We measure trees at harvesting operations before and after they are cut into products. The kind of tree harvested and the difference between what is inventoried and what is cut yield two kinds of information: 1) what kind of wood fiber is being used for industrial forest products, and 2) how much wood remains as residue. In addition, the New York Department of Environmental Conservation (1981) has published information on the sources of wood fiber used for fuelwood, the most important nonindustrial wood product. When we supplement our industrial wood use information with this fuelwood information, we can identify what sources of wood fiber are being used for the three major forest products in New York: sawlogs and veneer logs, pulpwood, and fuelwood.

The proportion of wood that is harvested from growing stock is different for the three major forest products (Fig. 6). For example, very little of the sawlog or veneer log biomass is harvested from nongrowing stock. Standards are much more restrictive for these products than for either pulpwood or fuelwood; more nongrowing stock can be used in products that do not require such high-quality material. Currently, pulpwood harvesters use about 20 percent nongrowing stock and fuelwood harvesters use 87 percent.

The proportion of growing stock used for fuelwood concerns forest-land managers today. However, fear that fuelwood harvesting is depleting supplies of quality timber may be unfounded. Only a small amount of the wood fiber used for fuelwood today is harvested from timber suited for high-value products like sawlogs and veneer logs.

Recovery of wood fiber may continue to improve if markets can be found for unconventional products. New products can be processed that better utilize the existing resource, and some of the traditional products can be processed using more nongrowing stock. Fuelwood and pulpwood harvesters exemplify these possibilities. At the time of the last inventory, only 10 percent of the pulpwood was harvested from nongrowing stock (Ferguson and Mayer 1970). Today, 20 percent of the pulpwood is harvested from nongrowing stock.

So far, the supply of nongrowing stock for low-value products like fuelwood has been ample. However, the proportion of nongrowing stock used for all products may change as more markets for fuelwood products are found. More low-value products may be harvested from high-quality material unless wood fiber potentials can be identified and emphasis placed on developing more cost-effective techniques to recover low-quality material.

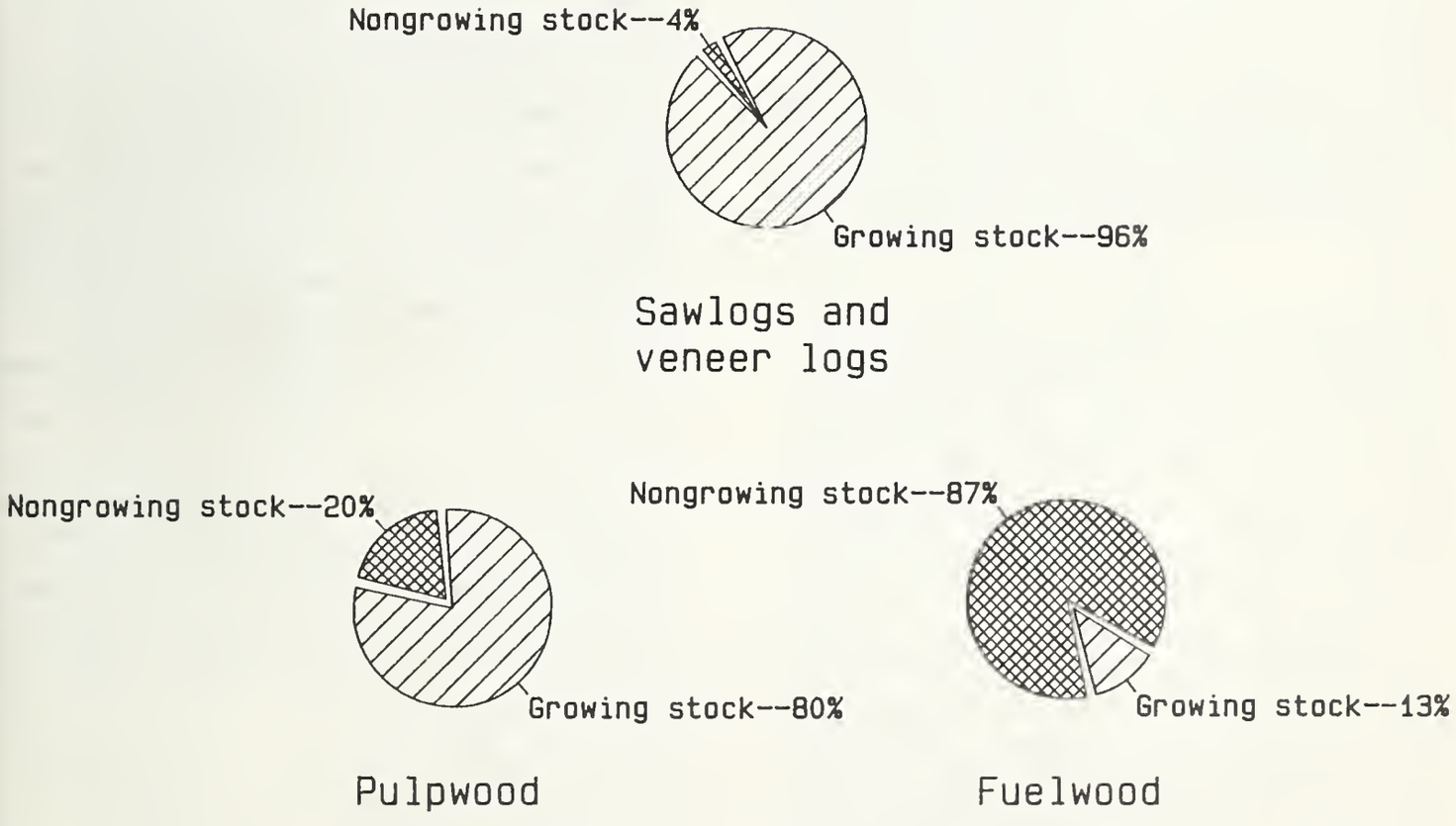


Figure 6.--Wood fiber used for three selected forest product groups in New York, 1979.

Improving Wood Fiber Recovery

Today, methods to improve recovery of wood fiber from timberlands are emphasized. Private landowners are being encouraged to use their resources better, and in some cases are leading the way. Public land managers are increasing revenues by harvesting aboveground tree biomass that was largely ignored in the past.

Most of the additional wood fiber harvested is converted to energy, but some is processed into other wood products. Pulpmills in particular are now using some additional sources of wood fiber. Reconstituted board products are being processed in New Hampshire and Maine, though not as yet in New York. Other uses like adding chips to sludge in municipal waste disposal are becoming more common, and the residential fuelwood market is strong in New York. During the 1980-81 heating season, an estimated 3.3 million cords (8.4 million green tons) of fuelwood were burned in residences across the state (New York Department of Environmental Conservation 1981). This volume of fuelwood exceeds the volume of wood removed for all industrial forest products during 1979, although most of the fuelwood came from nongrowing stock.

It is apparent why so much concern has been expressed recently about the increasing use of timberlands for energy and similar products. However, harvesting for industrial wood products today wastes half of the aboveground wood resource. Except when wood is harvested for pulp or reconstituted board products, industrial wood harvesters cannot use certain parts of the resource, and will leave much of it behind as wood residue. Harvesting products like fuelwood captures what is not used for the more conventional industrial wood products, rather than competing for the same sources of roundwood.

Residues

The most important untapped sources of wood fiber are dead trees, logging residues, manufacturing residues, and material left behind when land is cleared (Bones 1980). These sources will be lost if they are not recovered quickly, and except for some dead trees, are all byproducts of forest land use. Consequently, these residues should be prime targets for recovery. Access to them has been gained already, or they are concentrated at or near the point of processing.

Wood processors traditionally use manufacturing residues first because these residues are the most accessible. However, the proportion of manufacturing residues left unused has decreased over the years. In 1967, about 24 percent of the wood residues generated from primary processing in New York were unused. Today, that proportion has shrunk to only 6 percent, or 0.1 million green tons (Nevel and others 1982). It has become more difficult to obtain manufacturing residues because other industries are competing for these residues.

Logging residues are an alternative; although more expensive, they may still be profitable to recover because the cost of getting to them has been absorbed by harvesting operations. In 1979, an estimated 2.0 million green tons of logging residue were generated by harvesting industrial wood products, although some had already been recovered for fuelwood. Of the total fuelwood consumed in New York during the 1980-81 heating season, 5 percent came from logging residues (New York Department of Environmental Conservation 1981). This means that 0.4 million green tons may have been recovered, leaving 1.6 million green tons unused.

Our assessment of logging and manufacturing shows how much of the aboveground resource is being removed by harvesting and processing industrial wood products, and how much is left behind. More than 13.2 million green tons were removed during 1979 for all wood products, including fuelwood. The 1.7 million green tons of unused manufacturing and logging residues were 13 percent of wood product removals, and have a number of potential uses. Pulpmills, processors of reconstituted board products, and residential fuelwood users will compete for most of the residues, especially where timber is in short supply.

Competition may not be severe for material left unused when land is cleared. We have assessed how much land area changed from a forest land use to a nonforest land use between inventories. The wood that is removed during land clearing operations is likely to be near residential fuelwood markets because most of the land cleared in New York was for urban, suburban, or related uses (Fig. 7). Housing and industrial development accounted for 28 percent of the commercial forest land area that was cleared between 1968 and 1980. An additional 30 percent was cleared for road and powerline rights-of-way, usually associated with the infringement of urban and suburban areas on forest land. Only 22 percent of the forest land was cleared for rural land uses like agriculture and mining.

Most of the material that is removed to clear land, regardless of the final land use, is not recovered for industrial wood products. Nearly 1.0 million green tons of aboveground tree biomass were removed annually in clearing almost 19.9 thousand acres of commercial forest land in New York. Only 16 percent was used for industrial wood products. Currently, about half of the remainder is used for fuelwood. In the past this material was piled and burned on the site, but ordinances often prevent this today. Recovering the material for fuelwood is an attractive alternative to trucking it to landfills.

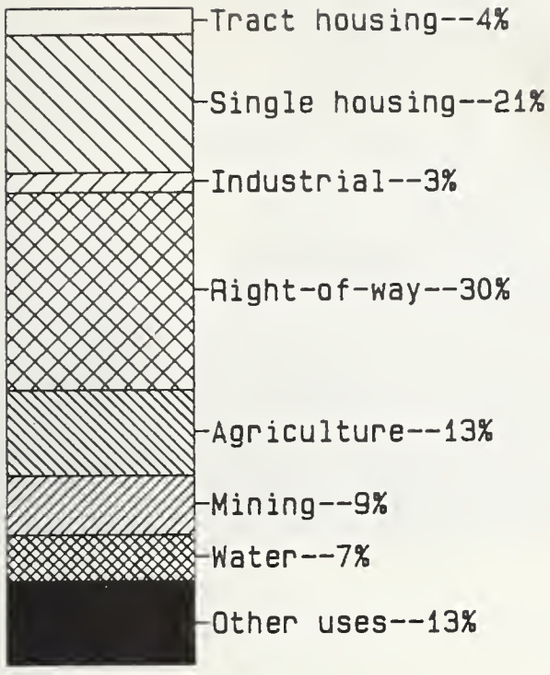


Figure 7.--Distribution of final land uses resulting from land clearing operations in New York, 1980.

Standing Trees

Wood residue is an immediate source of additional fiber, but it is only one alternative. For other sources, we must turn to the resource itself. How much would be available from the standing wood fiber supply if whole-tree chipping were used? According to Young[3], three factors significantly affect the availability of standing timber: land use regulation, terrain condition, and landowner attitudes.

I cannot address the problem of land use regulation here, but it is possible to identify how landowners feel about harvesting, and how much of the forest land base is excluded because of steep slopes or limited access. Tract size is another important limitation because the smaller tracts may restrict harvesting. Landowner attitudes are socioeconomic limitations, while both tract size and terrain condition impose physical limitations.

[3]Young, Harold E. Forest biomass as a renewable source of energy: inventory, productivity, and availability. Prepared for: UNITAR conference on long term energy resources; 1979 November 26 - December 7; Montreal, Canada. [Unpublished]. 18 p.

Whole-tree chippers, especially the larger models, are expensive to operate and move. Huyler (1982) found that a commercial chipping operation using a 22-inch whole-tree chipper and producing a 15.3 green tons per hour must run 7 hours each day to break even. To offset the high capital investment required, areas to be harvested must be large and close together. Local costs will dictate the minimum acreage required, but whole-tree chipping may not be profitable on less than 25 acres with a 25-mile move (Percival 1982). In New York, whole-tree chipping may not be profitable on less than 50 acres since the distance between tracts may be more than 25 miles.

Small stands of timber contain most of the aboveground tree biomass in New York. Stands of less than 50 acres account for almost 50 percent of the aboveground biomass (Table 7). Stands of more than 100 acres account for only 25 percent of the aboveground tree biomass.

The amount of aboveground tree biomass in stands varies across the state. Most of the smaller blocks of land can be found in western and southeastern New York, where the proportion of aboveground tree biomass in stands of more than 100 acres could conceivably drop to less than 25 percent as more land is tied up in smaller ownerships. Larger stand sizes are more common in northern New York, but there are more accessibility problems.

Slope and the distance to the nearest road affect accessibility the most. However, only 8 percent of the total wood fiber is on land where slopes exceed 30 percent or where the nearest road is more than 2 miles away (Monteith 1981). This small percentage could probably be reached if timber harvesters used cable logging systems or traveled farther into timberlands to recover aboveground tree biomass.

The most important socioeconomic constraint is how private forest-land owners feel about timber harvesting on their land, but it is a complex issue. Not only is there frequent turnover among landowners, but each landowner's intention to harvest may change. Certain groups of landowners may be opposed to harvesting timber because of environmental concerns or past experience with loggers. A short distance away other groups of landowners may be very receptive to harvesting, and may feel that harvesting aboveground tree biomass is the most efficient way to leave the stand aesthetically pleasing after harvesting. Therefore, any conclusions we draw are at best, tentative.

Each time we inventory a state we send questionnaires to a sample of private forest-land owners. We received 1,641 responses from 2,774 questionnaires sent out during 1979 to New York forest-land owners. These questionnaires help to identify certain attitudes of private forest-land owners that will affect the availability of the resource. The most important is the owner's intention to harvest.

Figure 8.--Landowners who have small parcels of forest land are less likely to harvest timber because they are concerned about environmental impacts to their woodlots. Small equipment has been designed to reduce environmental impacts on these sites.

Birch (1983) found that more than 14.4 million acres of commercial forest land is owned by private forest-land owners, and that most of this is available for harvesting (Table 8). Almost 69 percent of the commercial forest land area -- 9.9 million acres -- is available.

The proportion available from nonindustrial private forest-land owners is related to how much acreage they own. I was unable to obtain detailed estimates of harvesting tendencies for very small ownerships: the 1- to 49-acre class is the smallest unit available for analysis. Approximately 56 percent of the commercial forest land area in ownerships of 1 to 49 acres is available for harvesting. This increases to 76 percent in ownerships of 500 acres or more. Assuming that the smallest ownerships are too small to be harvested, 6.4 million acres are still available from nonindustrial private forest land.

As expected, almost all of the land owned by forest industry is available for harvesting. Adding forest industry lands to nonindustrial private forest lands that are available brings the amount of commercial forest land available for harvesting to 7.3 million acres.

Much of the 4.5 million acres presently considered unavailable because of landowner attitudes may become available as better harvesting systems are developed. Small harvesting and wood transport equipment has been developed that is economical and leaves the stand in better condition than the more conventional equipment (Fig. 8). Increased use of small equipment and cable logging systems will help landowners to realize that timber harvesting need not cause irreversible damage to their woodlots.

Opportunities

The merchantable bole portion will continue to be the most valuable part of the tree, but the increased use of tree biomass for pulp, reconstituted board products, and energy indicates that we may be heading toward a more fiber-based wood products industry. Conservative projections by the U.S. Forest Service for the years 1976 to 2030 (U.S. Department of Agriculture 1982) show lumber demand increasing by 40 percent, but paper and board demand increasing by 145 percent. In addition, the U.S. Forest Service expects residential fuelwood use to rise from 6 to 26 million cords -- a 333-percent increase.

Some of the new fiber-based products have not yet been manufactured in New York, but they may in the future because there is biomass available and the demand for these products is increasing. Residues alone can support a number of new industrial and nonindustrial ventures in the state. For example, the 1.7 million green tons available represent 0.014 quads[4] of energy. That is almost 20 percent of what was burned in New York households as fuelwood during the 1980-81 heating season. There are other sources as well; the cull trees, previously noncommercial tree species, salvable dead trees, and small trees scattered throughout New York's timberlands can also be used for energy or fiber.

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[4]A quad is the accepted unit of measure for expressing energy values; it is equal to 1 quadrillion btu (british thermal units).

Most of the biomass is available for harvesting, but on some sites it may be advantageous to leave the tree tops. The branches contain about 40 percent of the nitrogen and about 30 percent of the calcium found in the total tree (foliage, branches, stem, and roots together) in a typical northern hardwood forest; the foliage contains very little of these nutrients (Marion 1979). On most sites, repeated removals of tree nutrients by conventional harvesting will not seriously affect site conditions, but removing tree tops as well may cause losses of nutrients that cannot be replenished (Foster and Morrison 1983).

Nutrient loss is an important consideration because nutrients are removed from the site whenever forest products are removed. Local conditions often will dictate how detrimental this will be. Some time in the future, tradeoffs must be developed between using the aboveground wood resource for products and leaving some of it behind to retain nutrients.

Recovering aboveground tree biomass for energy and wood fiber products can have far-reaching consequences, both positive and negative. The purpose of this paper is not to address all of these implications. A publication by Johnson and others (1980) clearly outlines the advantages and disadvantages.

One important concern is that using aboveground tree biomass has been primarily a response to economic stimuli. For example, it was rising energy costs in the 1970's that caused alternative sources to be found from the wood resource. That this may have utilized the resource better was largely an afterthought. Although improved utilization is now being stressed, harvesting biomass in the future will take an economic commitment. The value resulting from processing unconventional fiber-based products has not yet offset the cost of obtaining the material in many places because of current markets and technologies. However, the opportunities are there if cost-effective measures can be found to improve wood fiber recovery for both industrial and nonindustrial wood products.

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Glossary

Aboveground Tree Biomass. The net green weight of wood and bark in all live trees above ground level. Net weight equals gross weight, less deductions for rotten cull.

Biomass. The quantity of material in any living organism measured in terms of its weight.

Commercial Forest Land. Forest land producing or capable of producing crops of industrial wood products (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization like forest preserves.

Commercial Species. Tree species presently or prospectively suitable for industrial wood products. Excludes species typically of small size, poor form, or inferior quality like hawthorn and sumac.

Cord. A unit of measure for stacked roundwood, containing 128 cubic feet of wood, bark, and air space. In the Northeast, a cord contains 85 cubic feet of solid wood. A standard cord, commonly 4 feet by 4 feet by 8 feet, is not the same as the "face cord" used in residential fuelwood marketing.

Cull Trees. (1) Live trees of commercial species that do not contain at least one 12-foot sawlog or two noncontiguous sawlogs, each 8 feet or longer, now or prospectively, and do not meet regional specifications for freedom from defect primarily because of rot (more than 50 percent of the cull volume in a tree is rotten), or because of roughness or poor form. (2) All live trees of noncommercial species.

Forest Industry Lands. Lands owned by companies or individuals operating industrial wood manufacturing plants.

Forest Land. Land at least 10 percent stocked (containing at least 7.5 square feet per acre of basal area) with trees of any size or land that formerly had such tree cover and is not currently developed for nonforest use. The minimum classification of forest land is 1 acre.

Fuelwood. Wood used by conversion to some form of energy, primarily residential use, and commonly expressed in terms of cords.

Growing-stock Trees. All live trees of commercial species, 5.0 inches dbh and larger, except rough and rotten trees.

Growing-stock Volume. Net volume, in cubic feet, of growing-stock trees from a 1-foot stump to a minimum 4.0-inch top diameter outside bark of the central stem, or to the point where the central stem breaks into limbs. Net volume equals gross volume, less deduction for cull.

Industrial Wood Manufacturing Plant. A plant that converts round timber into wood products such as woodpulp, lumber, veneer, cooperage, and dimension products.

Industrial Wood Products. All commercial roundwood products except residential fuelwood.

Logging Residues. The unused portions of growing-stock trees harvested or killed in the process of logging.

Manufacturing Residues. Wood materials that are generated when round timber (roundwood) is converted into wood products. This includes slabs, edgings, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and pulp screenings.

Merchantable Stem. The main stem of the tree between the 1-foot stump and the 4-inch top; wood and bark.

Noncommercial Tree Species. Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial forest products.

Nonforest Land. Land that has never supported forests, or land formerly forested but now in nonforest use such as cropland, pasture, residential areas, and highways.

Nongrowing-stock. Cull trees, noncommercial tree species, small trees, and the tops of growing-stock trees.

Nonindustrial Private Forest Land. All commercial forest land other than land owned by forest industry; or by federal, state or local agencies (public land).

Nonindustrial Wood Products. All roundwood products not used in the industrial sector, such as residential fuelwood.

Pulpwood. Any log or bolt from which woodpulp is to be made; usually measured in bolts of 4, 5, or 8 feet, and somewhat smaller in diameter than sawlogs or veneer logs. Includes whole-tree chips or chipped plant byproducts (manufacturing residues that are used).

Reconstituted Board Products. Any wood product that has been manufactured by converting wood to particles by a mechanical process and then bonding them together. Includes flakeboard, particleboard, oriented strand board, fiberboard, hardboard, and chipboard.

Removals. The amount of wood removed from the inventory for roundwood products plus logging residues, the amount destroyed during land clearing, and the amount of standing trees growing on land that was reclassified from commercial forest land to noncommercial forest land (forest preserves).

Salvable Dead Trees. Trees that have died from natural causes but can still be recovered for a forest product.

Sawtimber. Live trees of commercial species at least 9.0 inches dbh for softwoods or 11.0 inches for hardwoods that contain at least one 12-foot sawlog or two noncontiguous 8-foot sawlogs, and that meet regional specifications for freedom from defect.

Sawtimber Volume. Net volume, in board feet, of sawtimber. Net volume equals gross volume less deductions for rot, sweep, and other defects that affect use for lumber.

Small Trees. Live trees that are less than 5.0 inches dbh, but larger than 1.0 inches dbh.

Stumps. The main stem of the tree between the ground level and 1-foot height; wood and bark.

Tree Tops. Branches and main stem above a 4-inch top diameter outside bark. Excludes foliage.

Index to Tables

Conversions and Equivalents

1 ft^3 softwoods = 0.027 green tons

1 ft^3 hardwoods = 0.033 green tons

1 standard cord = 85 ft^3 solid wood

1 standard cord = 212 ft^3 chips

1 standard cord = 2.56 green tons

1 green ton = 8.5 million btu

Table 1.--Net aboveground tree biomass of all live trees on commercial forest land and sampling errors, by county and geographic unit, New York, 1980

County[a] and geographic unit	Total aboveground tree biomass	Sampling errors
	--- thousand green tons ---	-- percent --
Cayuga/Seneca	13,095.1	12
Erie	16,352.4	8
Genesee	5,759.9	15
Livingston	8,739.8	14
Madison	11,805.7	9
Monroe	4,668.4	15
Niagara	2,823.4	23
Onondaga	9,859.8	11
Ontario	8,985.0	12
Orleans	4,293.3	17
Oswego	28,340.6	6
Wayne	6,722.5	16
Wyoming	10,680.6	11
Yates	4,691.4	19
Lake Plain	136,817.9	3.1
Allegany	30,397.3	7
Cattaraugus	33,510.2	7
Chautauqua	26,461.0	8
Steuben	36,902.5	6
Southwest Highlands	127,271.0	3.4
Broome	18,769.4	8
Chemung	11,398.7	9
Chenango	27,860.3	8
Cortland	11,483.9	6
Delaware	54,188.1	4
Otsego	25,829.3	5
Schuyler	9,474.6	10
Tioga	14,454.1	8
Tompkins	13,251.1	8
South-central Highlands	186,709.5	2.2
Clinton	37,458.2	6
Franklin	55,862.3	4
Jefferson	15,375.1	15
St. Lawrence	75,877.2	4
St. Lawrence-N. Adirondack	184,572.8	2.6
Fulton	12,391.9	9
Herkimer	25,002.4	6
Lewis	38,636.5	5
Oneida	33,475.4	8
Western Adirondack	109,506.2	3.5

Table 1.--Net aboveground tree biomass of all live trees on commercial forest land and sampling errors, by county and geographic unit, New York, 1980

County[a] and geographic unit	Total aboveground tree biomass	Sampling errors
	--- thousand green tons ---	-- percent --
Essex	51,614.0	6
Hamilton	28,812.4	5
Warren	33,713.5	6
Eastern Adirondack	114,139.9	3.3
Albany	9,549.7	13
Columbia	18,761.4	7
Montgomery	4,616.6	21
Rensselaer	21,989.3	7
Saratoga	30,623.0	6
Schenectady	4,879.3	16
Washington	19,359.1	8
Capitol District	109,778.4	3.3
Dutchess	23,395.6	7
Greene	21,728.0	6
Orange	18,766.6	12
Putnam	7,211.3	7
Schoharie	19,836.8	7
Suffolk	5,291.1	27
Sullivan	47,676.9	6
Ulster	42,644.5	6
Westchester/Rockland	9,024.3	11
Catskill-Lower Hudson	195,575.1	2.7
Total, all units	1,164,370.8	1.0

[a] Multi-county groupings are used for counties with too few forested field plots or with other sampling anomalies. This is done when more detailed county-level data are presented in order to minimize sampling errors.

Table 2.--Net aboveground tree biomass of all live softwood trees on commercial forest land, by county, geographic unit, and selected species, New York, 1980

County[a] and geographic unit	Eastern white and red pines	Spruce and balsam fir	Eastern hemlock	Other softwoods	Total softwoods
	thousand green tons				
Cayuga/Seneca	78.1	207.4	615.5	82.3	983.3
Erie	1,790.3	92.6	2,027.9	475.0	4,385.8
Genesee	71.7	.0	.0	97.2	168.9
Livingston	787.1	135.4	601.6	229.4	1,753.5
Madison	888.9	938.7	1,139.4	132.6	3,099.6
Monroe	.0	.0	66.6	392.4	459.0
Niagara	.0	.0	.0	.0	.0
Onondaga	127.9	213.5	491.5	79.1	912.0
Ontario	621.3	46.4	73.4	29.5	770.6
Orleans	.0	.0	118.9	.0	118.9
Oswego	2,239.5	72.7	3,310.4	1,110.6	6,733.2
Wayne	219.2	13.5	100.5	.0	333.2
Wyoming	34.4	529.1	1,082.1	400.8	2,046.4
Yates	268.7	.0	617.8	187.2	1,073.7
Lake Plain	7,127.1	2,249.3	10,245.6	3,216.1	22,838.1
Allegany	646.0	1,190.6	1,434.7	314.7	3,586.0
Cattaraugus	1,122.2	458.6	1,875.0	317.0	3,772.8
Chautauqua	819.7	269.7	2,660.8	628.8	4,379.0
Steuben	1,791.3	.0	2,834.4	54.4	4,680.1
Southwest Highlands	4,379.2	1,918.9	8,804.9	1,314.9	16,417.9
Broome	348.6	.0	1,870.9	53.7	2,273.2
Chemung	892.3	647.2	1,034.8	204.1	2,778.4
Chenango	3,357.3	1,454.6	3,801.4	625.7	9,239.0
Cortland	537.0	.0	211.6	600.1	1,348.7
Delaware	1,740.8	24.8	2,685.4	.0	4,451.0
Otsego	2,514.9	65.0	4,333.7	.0	6,913.6
Schuyler	1,105.2	.0	612.2	123.4	1,840.8
Tioga	1,692.8	497.0	903.7	100.2	3,193.7
Tompkins	1,223.7	.0	343.3	219.4	1,786.4
South-central Highlands	13,412.6	2,688.6	15,797.0	1,926.6	33,824.8
Clinton	2,987.3	4,067.4	522.9	2,418.9	9,996.5
Franklin	2,864.9	8,583.0	2,141.7	1,287.9	14,877.5
Jefferson	2,230.7	503.1	736.8	272.0	3,742.6
St. Lawrence	3,179.7	9,023.1	2,877.3	3,744.4	18,824.5
St. Lawrence-N. Adirondack	11,262.6	22,176.6	6,278.7	7,723.2	47,441.1
Fulton	884.9	434.7	2,927.0	122.2	4,368.8
Herkimer	616.7	4,001.5	2,770.7	62.6	7,451.5
Lewis	2,482.8	3,198.5	1,492.8	653.5	7,827.6
Oneida	3,022.5	245.7	3,624.0	481.7	7,373.9
Western Adirondack	7,006.9	7,880.4	10,814.5	1,320.0	27,021.8

Table 2.--Net aboveground tree biomass of all live softwood trees on commercial forest land, by county, geographic unit, and selected species, New York, 1980

County[a] and geographic unit	Eastern white and red pines	Spruce and balsam fir	Eastern hemlock	Other softwoods	Total softwoods
	thousand green tons				
Essex	8,986.2	4,401.4	5,125.5	1,447.5	19,960.6
Hamilton	634.1	7,356.9	1,603.2	33.3	9,627.5
Warren	10,535.0	995.1	5,483.8	528.8	17,542.7
Eastern Adirondack	20,155.3	12,753.4	12,212.5	2,009.6	47,130.8
Albany	2,884.8	.0	1,135.2	316.9	4,336.9
Columbia	2,865.2	576.6	1,119.8	93.1	4,654.7
Montgomery	834.6	.0	1,414.7	.0	2,249.3
Rensselaer	3,013.1	250.5	3,023.7	81.9	6,369.2
Saratoga	5,168.4	110.0	4,934.3	144.1	10,356.8
Schenectady	228.9	.0	367.0	55.6	651.5
Washington	1,379.4	34.0	3,667.6	81.4	5,162.4
Capitol District	16,374.4	971.1	15,662.3	773.0	33,780.8
Dutchess	222.0	44.9	594.0	816.1	1,677.0
Greene	4,425.8	98.1	1,277.1	242.2	6,043.2
Orange	221.2	554.6	998.6	595.9	2,370.3
Putnam	.0	.0	190.8	3.2	194.0
Schoharie	2,910.6	167.8	1,644.7	429.2	5,152.3
Suffolk	943.1	.0	.0	829.8	1,772.9
Sullivan	3,445.0	840.9	5,451.2	812.8	10,549.9
Ulster	5,163.5	15.5	6,630.7	312.2	12,121.9
Westchester/Rockland	93.4	.0	66.2	115.2	274.8
Catskill-Lower Hudson	17,424.6	1,721.8	16,853.3	4,156.6	40,156.3
Total, all units	97,142.7	52,360.1	96,668.8	22,440.0	268,611.6

[a] Multi-county groupings are used for counties with too few forested field plots or with other sampling anomalies. This is done when more detailed county-level data are presented in order to minimize sampling errors.

Table 3.--Net aboveground tree biomass of all live hardwood trees on commercial forest land, by county, geographic unit, and selected species, New York, 1980

County[a] and geographic unit	Oaks	Hard Maples	Soft Maples	Other Hardwoods	Total Hardwoods
	thousand green tons				
Cayuga/Seneca	746.0	2,705.9	2,691.3	5,968.6	12,111.8
Erie	486.4	3,343.8	1,683.7	6,452.7	11,966.6
Genesee	337.2	539.6	894.4	3,819.8	5,591.0
Livingston	1,780.9	1,437.0	819.3	2,949.1	6,986.3
Madison	296.7	2,802.3	486.4	5,120.7	8,706.1
Monroe	780.2	526.1	458.6	2,444.5	4,209.4
Niagara	735.9	161.2	22.8	1,903.5	2,823.4
Onondaga	26.6	1,482.0	2,573.8	4,865.4	8,947.8
Ontario	2,408.6	1,074.5	429.6	4301.7	8,214.4
Orleans	166.2	132.5	453.5	3,422.2	4,174.4
Oswego	181.8	2,811.2	8,782.0	9,832.4	21,607.4
Wayne	65.1	1,394.4	1,126.5	3,803.3	6,389.3
Wyoming	221.1	2,527.0	510.0	5,376.1	8,634.2
Yates	1,727.0	371.7	294.1	1,224.9	3,617.7
Lake Plain	9,959.7	21,309.2	21,226.0	61,484.9	113,979.8
Allegany	4,672.8	6,184.0	4,551.0	11,403.5	26,811.3
Cattaraugus	4,180.2	8,378.3	3,476.7	13,702.2	29,737.4
Chautauqua	896.9	6,794.0	2,928.1	11,463.0	22,082.0
Steuben	5,212.5	7,509.5	2,661.2	16,839.2	32,222.4
Southwest Highlands	14,962.4	28,865.8	13,617.0	53,407.9	110,853.1
Broome	4,274.5	2,437.6	3,863.5	5,920.6	16,496.2
Chemung	3,122.2	890.1	1,248.3	3,359.7	8,620.3
Chenango	2,699.0	4,437.8	4,205.4	7,279.1	18,621.3
Cortland	159.4	4,080.3	1,240.6	4,654.9	10,135.2
Delaware	3,633.4	11,988.5	15,664.3	18,450.9	49,737.1
Otsego	2,408.4	3,698.7	4,622.6	8,186.0	18,915.7
Schuyler	1,838.3	1,526.1	1,102.9	3,166.5	7,633.8
Tioga	2,616.4	1,140.7	3,464.2	4,039.1	11,260.4
Tompkins	1,955.1	1,919.8	1,118.6	6,471.2	11,464.7
South-central Highlands	22,706.7	32,119.6	36,530.4	61,528.0	152,884.7
Clinton	1,430.8	6,228.9	4,832.6	14,969.4	27,461.7
Franklin	109.9	10,629.3	11,482.5	18,763.1	40,984.8
Jefferson	677.5	3,560.6	1,138.4	6,256.0	11,632.5
St. Lawrence	723.7	9,889.9	14,131.5	32,307.6	57,052.7
St. Lawrence-N. Adirondack	2,941.9	30,308.7	31,585.0	72,296.1	137,131.7
Fulton	238.3	1,360.8	1,698.3	4,725.7	8,023.1
Herkimer	97.5	3,703.2	4,482.4	9,267.8	17,550.9
Lewis	206.6	5,946.4	7,971.4	16,684.5	30,808.9
Oneida	872.7	5,078.8	6,055.0	14,095.0	26,101.5
Western Adirondack	1,415.1	16,089.2	20,207.1	44,773.0	82,484.4

Table 3.--Net aboveground tree biomass of all live hardwood trees on commercial forest land, by county, geographic unit, and selected species, New York, 1980

County[a] and geographic unit	Oaks	Hard Maples	Soft Maples	Other Hardwoods	Total Hardwoods
	thousand green tons				
Essex	3,261.2	8,540.1	2,336.8	17,515.3	31,653.4
Hamilton	.0	4,739.2	2,108.5	12,337.2	19,184.9
Warren	2,493.9	4,193.2	1,823.2	7,660.5	16,170.8
Eastern Adirondack	5,755.1	17,472.5	6,268.5	37,513.0	67,009.1
Albany	373.7	2,041.7	234.5	2,562.9	5,212.8
Columbia	5,764.3	1,349.6	1,233.2	5,759.6	14,106.7
Montgomery	359.6	457.3	205.6	1,344.8	2,367.3
Rensselaer	3,655.9	2,764.1	4,453.5	4,746.6	15,620.1
Saratoga	4,796.7	2,382.7	4,002.4	9,084.4	20,266.2
Schenectady	856.5	678.0	389.6	2,303.7	4,227.8
Washington	3,006.0	2,492.0	1,340.2	7,358.5	14,196.7
Capitol District	18,812.7	12,165.4	11,859.0	33,160.5	75,997.6
Dutchess	7,210.5	2,375.1	2,856.2	9,276.8	21,718.6
Greene	2,715.0	5,182.5	1,608.1	6,179.2	15,684.8
Orange	6,670.9	1,040.3	1,711.9	6,973.2	16,396.3
Putnam	3,357.7	354.5	1,178.0	2,127.1	7,017.3
Schoharie	3,363.5	3,885.2	1,681.6	5,754.2	14,684.5
Suffolk	2,940.8	50.0	53.0	474.4	3,518.2
Sullivan	11,918.3	4,848.4	8,758.0	11,602.3	37,127.0
Ulster	9,993.8	4,665.9	4,842.8	11,020.1	30,522.6
Westchester/Rockland	2,633.2	337.9	909.1	4,869.3	8,749.5
Catskill-Lower Hudson	50,803.7	22,739.8	23,598.7	58,276.6	155,418.8
Total, all units	127,357.3	181,070.2	164,891.7	422,440.0	895,759.2

[a] Multi-county groupings are used for counties with too few forested field plots or with other sampling anomalies. This is done when more detailed county-level data are presented in order to minimize sampling errors.

Table 4.--Commercial forest land area and net aboveground tree biomass of all live trees per acre of commercial forest land, by county and geographic unit, New York, 1980

County[a] and geographic unit	Commercial forest land	Total aboveground biomass per acre
	-- thousand acres --	-- green tons/acre --
Cayuga/Seneca	198.6	65.9
Erie	229.6	71.2
Genesee	94.1	61.2
Livingston	120.1	72.8
Madison	196.2	60.2
Monroe	96.1	48.6
Niagara	65.1	43.4
Onondaga	199.9	49.3
Ontario	142.7	63.0
Orleans	74.2	57.9
Oswego	416.9	68.0
Wayne	101.9	66.0
Wyoming	145.0	73.7
Yates	84.0	55.8
Lake Plain	2,164.4	63.2
Allegany	421.5	72.1
Cattaraugus	470.3	71.3
Chautauqua	362.6	73.0
Steuben	478.1	77.2
Southwest Highlands	1,732.5	73.5
Broome	279.4	67.2
Chemung	158.0	72.1
Chenango	340.3	81.9
Cortland	158.1	72.6
Delaware	624.3	86.8
Otsego	369.5	69.9
Schuyler	122.2	77.5
Tioga	193.6	74.7
Tompkins	171.5	77.3
South-central Highlands	2,416.9	77.3
Clinton	465.1	80.5
Franklin	655.1	85.3
Jefferson	359.6	42.8
St. Lawrence	1,118.6	67.8
St. Lawrence-N. Adirondack	2,598.4	71.0
Fulton	179.4	69.1
Herkimer	388.1	64.4
Lewis	574.1	67.3
Oneida	413.2	81.0
Western Adirondack	1,554.8	70.4

Table 4.--Commercial forest land area and net aboveground tree biomass of all live trees per acre of commercial forest land, by county and geographic unit, New York, 1980

County[a] and geographic unit	Commercial forest land	Total aboveground biomass per acre
	-- thousand acres --	-- green tons/acre --
Essex	557.9	92.5
Hamilton	373.8	77.1
Warren	336.3	100.2
Eastern Adirondack	1,268.0	90.0
Albany	162.2	58.9
Columbia	216.9	86.5
Montgomery	81.3	56.8
Rensselaer	253.9	86.6
Saratoga	356.2	86.0
Schenectady	66.7	73.2
Washington	257.0	75.3
Capitol District	1,394.8	78.7
Dutchess	298.6	78.4
Greene	252.3	86.1
Orange	259.0	72.5
Putnam	89.9	80.2
Schoharie	256.7	77.3
Suffolk	101.0	52.4
Sullivan	463.9	102.8
Ulster	428.9	99.4
Westchester/Rockland	125.7	71.8
Catskill-Lower Hudson	2,276.0	85.9
Total, all units	15,405.8	75.6

[a] Multi-county groupings are used for counties with too few forested field plots or with other sampling anomalies. This is done when more detailed county-level data are presented in order to minimize sampling errors.

Table 5.--Net aboveground tree biomass of all live trees on commercial forest land, by county, geographic unit, and source, New York, 1980

County[a] and geographic unit	Growing stock			Cull trees[d]	Other sources[e]	All sources
	stem[b]	tops[c]	total			
	thousand green tons					
Cayuga/Seneca	7,599.3	2,307.9	9,907.2	1,046.7	2,141.2	13,095.1
Erie	9,107.2	2,979.1	12,086.3	1,296.8	2,969.3	16,352.4
Genesee	2,506.6	858.5	3,365.1	270.2	2,124.6	5,759.9
Livingston	4,748.0	1,502.0	6,250.0	1,099.8	1,390.0	8,739.8
Madison	6,134.8	2,215.0	8,349.8	1,200.7	2,255.2	11,805.7
Monroe	2,808.8	904.8	3,713.6	286.7	668.1	4,668.4
Niagara	1,640.1	491.6	2,131.7	209.7	482.0	2,823.4
Onondaga	5,080.4	1,674.7	6,755.1	1,240.2	1,864.5	9,859.8
Ontario	5,377.1	1,647.4	7,024.5	271.1	1,689.4	8,985.0
Orleans	2,359.5	720.7	3,080.2	282.9	930.2	4,293.3
Oswego	15,050.3	5,269.6	20,319.9	3,024.8	4,995.9	28,340.6
Wayne	3,929.0	1,263.5	5,192.5	373.0	1,157.0	6,722.5
Wyoming	5,642.2	2,019.6	7,661.8	860.8	2,158.0	10,680.6
Yates	2,473.5	835.6	3,309.1	619.1	763.2	4,691.4
Lake Plain	74,456.8	24,690.0	99,146.8	12,082.5	25,588.6	136,817.9
Allegany	17,279.3	5,603.5	22,882.8	2,274.2	5,240.3	30,397.3
Cattaraugus	20,257.1	6,290.7	26,547.8	2,483.5	4,478.9	33,510.2
Chautauqua	15,585.9	4,923.1	20,509.0	2,144.2	3,807.8	26,461.0
Steuben	21,686.1	6,769.1	28,455.2	2,883.9	5,563.4	36,902.5
Southwest Highlands	74,808.4	23,586.4	98,394.8	9,785.8	19,090.4	127,271.0
Broome	10,978.7	3,628.3	14,607.0	1,375.9	2,786.5	18,769.4
Chemung	7,315.9	2,247.4	9,563.3	326.6	1,508.8	11,398.7
Chenango	15,399.4	5,155.9	20,555.3	2,936.5	4,368.5	27,860.3
Cortland	6,571.4	2,056.8	8,628.2	1,102.4	1,753.3	11,483.9
Delaware	31,311.7	9,708.5	41,020.2	5,835.1	7,332.8	54,188.1
Otsego	14,222.8	4,817.3	19,040.1	2,954.9	3,834.3	25,829.3
Schuyler	5,465.6	1,673.7	7,139.3	519.1	1,816.2	9,474.6
Tioga	8,525.1	2,713.1	11,238.2	998.0	2,217.9	14,454.1
Tompkins	8,350.0	2,603.7	10,953.7	1,001.2	1,296.2	13,251.1
South-central Highlands	108,140.6	34,604.7	142,745.3	17,049.7	26,914.5	186,709.5
Clinton	19,502.7	6,565.0	26,067.7	3,159.8	8,230.7	37,458.2
Franklin	30,862.4	11,062.9	41,925.3	4,968.6	8,968.4	55,862.3
Jefferson	8,275.1	2,642.8	10,917.9	1,550.5	2,906.7	15,375.1
St. Lawrence	36,338.3	13,409.9	49,748.2	9,947.9	16,181.1	75,877.2
St. Lawrence-N. Adirondack	94,978.5	33,680.6	128,659.1	19,626.8	36,286.9	184,572.8
Fulton	5,991.8	2,313.7	8,305.5	1,941.3	2,145.1	12,391.9
Herkimer	12,587.8	4,910.7	17,498.5	3,665.4	3,838.5	25,002.4
Lewis	19,771.4	6,780.8	26,552.2	5,341.6	6,742.7	38,636.5
Oneida	18,634.3	5,594.4	24,228.7	4,210.2	5,036.5	33,475.4
Western Adirondack	56,985.3	19,599.6	76,584.9	15,158.5	17,762.8	109,506.2

Table 5.--Net aboveground tree biomass of all live trees on commercial forest land, by county, geographic unit, and source, New York, 1980

County[a] and geographic unit	Growing stock			Cull trees[d]	Other sources[e]	All sources
	stem[b]	tops[c]	total			
	thousand green tons					
Essex	31,537.2	9,775.2	41,312.4	2,701.0	7,600.6	51,614.0
Hamilton	14,036.6	5,581.6	19,618.2	3,165.3	6,028.9	28,812.4
Warren	19,554.4	5,766.6	25,321.0	3,275.5	5,117.0	33,713.5
Eastern Adirondack	65,128.2	21,123.4	86,251.6	9,141.8	18,746.5	114,139.9
Albany	5,204.1	1,524.3	6,728.4	1,104.7	1,716.6	9,549.7
Columbia	11,573.1	3,578.2	15,151.3	1,398.3	2,211.8	18,761.4
Montgomery	2,836.2	859.1	3,695.3	520.0	401.3	4,616.6
Rensselaer	13,221.6	4,194.1	17,415.7	1,914.6	2,659.0	21,989.3
Saratoga	17,190.9	5,287.5	22,478.4	3,214.1	4,930.5	30,623.0
Schenectady	2,589.7	859.1	3,448.8	620.2	810.3	4,879.3
Washington	11,010.7	3,645.3	14,656.0	1,864.9	2,838.2	19,359.1
Capitol District	63,626.3	19,947.6	83,573.9	10,636.8	15,567.7	109,778.4
Dutchess	14,097.4	4,332.9	18,430.3	1,581.0	3,384.3	23,395.6
Greene	12,494.0	3,914.1	16,408.1	2,029.7	3,290.2	21,728.0
Orange	11,845.2	3,521.8	15,367.0	1,010.2	2,389.4	18,766.6
Putnam	4,781.5	1,394.5	6,176.0	377.8	657.5	7,211.3
Schoharie	10,549.0	3,482.8	14,031.8	2,723.0	3,082.0	19,836.8
Suffolk	2,962.2	986.4	3,948.6	394.7	947.8	5,291.1
Sullivan	29,245.3	8,912.5	38,157.8	3,170.5	6,348.6	47,676.9
Ulster	27,247.3	7,977.9	35,225.2	2,883.4	4,535.9	42,644.5
Westchester/Rockland	5,641.5	1,656.7	7,298.2	442.9	1,283.2	9,024.3
Catskill-Lower Hudson	118,863.4	36,179.6	155,043.0	14,613.2	25,918.9	195,575.1
Total, all units	656,987.5	213,411.9	870,399.4	108,095.1	185,876.3	1,164,370.8

[a] Multi-county groupings are used for counties with too few forested field plots or with other sampling anomalies. This is done when more detailed county-level data are presented in order to minimize sampling errors.
[b] Bole portion of trees 5.0 inches dbh and larger.
[c] Stem and branches above a 4.0-inch top diameter outside bark.
[d] Includes entire tree aboveground of rough and rotten trees and noncommercial tree species.
[e] Includes stumps of all live trees 5.0 inches dbh and larger and entire tree aboveground of all trees between 1.0 inches and 5.0 inches dbh.

Table 6.--Net green weight[a] of industrial roundwood harvested[b] from commercial forest land, by region, species group, and product group, New York, 1979

Region and species group	Sawlogs	Pulpwood	Other products[c]	All products
	thousand green tons			
Southwestern region:				
Softwoods	231.8	28.7	13.4	273.9
Hardwoods	1,151.9	104.0	51.3	1,307.2
Total	1,383.7	132.7	64.7	1,581.1
Northern region:				
Softwoods	312.7	220.5	9.2	542.4
Hardwoods	527.5	1,175.2	59.3	1,762.0
Total	840.2	1,395.7	68.5	2,304.4
Southeastern region:				
Softwoods	220.3	64.7	2.9	287.9
Hardwoods	422.5	159.5	20.9	602.9
Total	642.8	224.2	23.8	890.8
All regions:				
Softwoods	764.8	313.9	25.5	1,104.2
Hardwoods	2,101.9	1,438.7	131.5	3,672.1
Total	2,866.7	1,752.6	157.0	4,776.3

[a] Softwoods were assumed to weigh 0.0274 green tons per cubic foot and hardwoods 0.0328 green tons per cubic foot.

[b] Based on a complete canvass of wood manufacturing plants in New York during 1979 (Nevel and others 1982). Does not include fuelwood or other removals that were not manufactured into industrial products.

[c] Includes cabin and veneer logs, piling, and stock for bats, bowls, handles, ladders, shingles, and miscellaneous dimension.

Table 7.--Net aboveground tree biomass of all live trees on commercial forest land, by stand area class and species group, New York, 1980

Stand area class	Softwoods	Hardwoods	All species
	thousand green tons		
1 - 49 acres	151,959.7	424,940.5	576,900.2
50 - 99 acres	69,696.0	224,829.2	294,525.2
100 - 499 acres	37,604.2	160,731.9	198,336.1
500+ acres	9,351.7	85,257.6	94,609.3
All classes	268,611.6	895,759.2	1,164,370.8

Table 8.--Area owned by private commercial forest land owners and area available for harvesting, by size of ownership, New York, 1980

Ownership size class	Total commercial forest land area	Available area	Proportion available
	thousand acres		percent
Forest Industry	1,034.7	941.9	91
1 - 49 acres	4,572.5	2,552.0	56
50 - 499 acres	6,670.7	4,774.1	72
500+ acres	2,148.9	1,632.0	76
All classes	14,426.8	9,900.0	69

Wharton, Eric H. Identifying aboveground wood fiber potentials in New York State. Resour. Bull. NE-82. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 25 p.

A statistical analytical report on the biomass resources of New York. The study was conducted in conjunction with the third forest survey of New York by the USDA Forest Service. Statistical findings are based on new 10-point variable radius plots, a canvass of wood manufacturers, timber utilization plots, and a mail canvass of private, commercial forest-land owners; all conducted in 1978 and 1979. Presents total aboveground biomass supplies, the use of biomass in the state for forest products, and sources of wood from residues and standing trees that can be used to improve wood fiber recovery.

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